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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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10/589,004

08/10/2006

Takeshi Nakata

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YOUNG & THOMPSON
209 Madison Street
Suite 500
ALEXANDRIA, VA 22314

EXAMINER

LIU, BENJAMIN T

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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No. 10/589,004	Applicant(s) NAKATA ET AL.	
	Examiner Benjamin Tzu-Hung Liu	Art Unit 2893	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 10 August 2006.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-15 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-15 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____ |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application |
| Paper No(s)/Mail Date <u>10/23/06, 8/10/06</u> . | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION***Drawings***

1. Figures 7 and 8 should be designated by a legend such as --Prior Art-- because only that which is old is illustrated. See MPEP § 608.02(g). Corrected drawings in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. The replacement sheet(s) should be labeled "Replacement Sheet" in the page header (as per 37 CFR 1.84(c)) so as not to obstruct any portion of the drawing figures. If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

Claim Rejections - 35 USC § 102(b)

2. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 1-2, 4-6, 8, and 14-15 are rejected under 35 U.S.C 102(b) as being anticipated by Watanabe (5,552,629).

With regard to claim 1, figure 6 of Watanabe discloses a semiconductor photo-detecting element comprising, wherein at least a buffer layer 12 of the first conductivity type P, a light-absorbing layer 13, a field buffer layer 14 of the first

Art Unit: 2893

conductivity type P, a multiplication layer 15, an etching stopper layer 115, a buffer layer 16 of the second conductivity type N, and a contact layer 17 of the second conductivity type N formed on a semiconductor substrate 11 in this order, and a field strength ("less than 300 kV/cm") applied to the etching stopper layer 115 is lower than a field strength ("600 kV/cm") applied to the multiplication layer 15. See col 7 lines 24-31.

With regard to claim 2, figure 6 of Watanabe discloses the limitation, wherein an impurity of the light-absorbing layer 13 is the first conductivity type P.

With regard to claim 4, figure 6 of Watanabe discloses the limitation, wherein a breakdown electrical field strength of the etching stopper layer 115 ("InP") is lower than a breakdown electrical field strength of the multiplication layer 15 ("InAlGaAs/InAlAs") and in that the field strength applied ("less than 300 kV/cm") to the etching stopper layer 115 is lower than the breakdown electrical field strength of the etching stopper layer 115 ("InP"). See col 5 lines 23-27.

With regard to claim 5, figure 6 of Watanabe discloses the breakdown electrical field strength of the etching stopper layer 115 ("InP") is lower than the breakdown electrical field strength of the multiplication layer 15 ("InAlGaAs/InAlAs"), and in that the field strength applied to the multiplication layer 15 is higher than the breakdown electrical field strength ("600 kV/cm") of the etching stopper layer 115 ("InP"). See col 5 lines 23-27 and col 7 line 25.

With regard to claim 6, figure 6 of Watanabe discloses the limitation, wherein between the multiplication layer ("InAlGaAs/InAlAs") 15 and the etching layer 115 there is provided a field buffer layer ("InAlAs") (top of multiplication

Art Unit: 2893

layer 15) of the second conductivity type N which relaxes the field of the multiplication layer 15.

With regard to claim 8, figure 6 of Watanabe discloses the limitation, wherein an impurity of the multiplication layer 15 is the second conductivity type N. See col 8 line 35.

With regard to claim 14, figure 6 of Watanabe discloses the limitation, wherein the layer thickness (d_m (cm)) (.23 μm) of the multiplication layer 15, the impurity concentration of the second conductivity type N (N_{dm} (cm^{-3})) ($2e^{15} cm^{-3}$), and the magnitude of the electric field (ΔE_m (kV/cm)) (600 kV/cm) which relaxes the field strength applied to the multiplication layer 15 satisfy the relationship $N_{dm} \geq k \times e_0 \times \Delta E_m / (q \times d_m)$; ($2e^{15} \geq ((12.5 * 8.85e-14 * 600) / 1.6e-19) / .000023$) (where k is the dielectric constant (12.5) of the multiplication layer 15, e_0 is the permittivity in a vacuum ($8.85e-14$ (permittivity in a vacuum, cm)), and q ($1.6e-19$ c) is the elementary quantity of electric discharge). See col 7 lines 24-31 and col 8 lines 35-39.

With regard to claim 15, figure 6 of Watanabe disclose the limitation, wherein the layer thickness (d_k (cm)) (1 μm) of the field buffer layer (top of multiplication layer 15) (InAlAs) of the second conductivity type N, the impurity concentration of the second conductivity type (N_{dk} (cm^{-3})) ($2e^{15} cm^{-3}$), and the magnitude of the electric field (ΔE_k (kV/cm)) (600 kV/cm) which relaxes the field strength applied to the multiplication layer 15 satisfy the relationship $N_{dk} \geq k \times e_0 \times \Delta E_k / (q \times d_k)$ ($2e^{15} \geq ((12.5 * 8.85e-14 * 600) / 1.6e-19) / .0001$); (where k (12.5) is the dielectric constant of the field buffer layer (top of mutliplcation layer

Art Unit: 2893

14, "InAlAs"), ϵ_0 is the permittivity in a vacuum (8.85×10^{-14} (permittivity in a vacuum, cm)), and q (1.6×10^{-19} c) is the elementary quantity of electric discharge).

See col 7 lines 24-31 and col 8 lines 35-39.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 3, 7, and 9 are rejected under 35 U.S.C 103(a) as being unpatentable over Watanabe (5,552,629) in view of Funaba (5,281,844).

With regard to claim 3, Watanabe discloses all the subject matter claimed except for the limitation, wherein an impurity of the light-absorbing layer is the second conductivity type.

However, figure 3 of Funaba discloses the limitation, wherein an impurity of the light-absorbing layer 12 is the second conductivity type N.

Therefore, it would have been obvious to one of ordinary skill in the art to form the device of Watanabe with the limitation of Funaba in order to improve the response of the device. See col 5 line 17.

With regard to claim 7, figure 6 of Watanabe discloses all the subject matter claimed except for the limitation, wherein an impurity of the multiplication layer is of the first conductivity type.

Art Unit: 2893

However, figure 3 of Funaba discloses the limitation, wherein an impurity of the multiplication layer 14 is of the first conductivity type p ("multiplication layer 14 may be p-type"). See col 6 line 14.

Therefore, it would have been obvious to one of ordinary skill in the art to form the device of Watanabe with the limitation of Funaba in order to improve the response of the device. See col 5 line 17.

With regard to claim 9, figure 6 of Watanabe discloses the limitation, wherein an impurity of the multiplication layer 15 is of the second conductivity type N.

Watanabe does not disclose that the multiplication layer has an impurity concentration of not less than $1 \times 10^{16} \text{ (cm}^{-3}\text{)}$.

However, Funaba discloses the multiplication layer 14 has an impurity concentration of not less than $1 \times 10^{16} \text{ (cm}^{-3}\text{)}$ (" $5 \times 10^{16} \text{ cm}^{-3}$ "). See col 5 line 28.

Therefore, it would have been obvious to one of ordinary skill in the art to form the device of Watanabe with the limitation of Funaba in order to improve the response of the device. See col 5 line 17.

Claims 10-13 are rejected under 35 U.S.C 103(a) as being unpatentable over Watanabe (5,552,629) in view of Clark (2003/0226952).

With regard to claim 10, Watanabe discloses all the subject matter claimed except for the limitation, wherein the multiplication layer is a single layer in which the ratio of elements forming the multiplication layer is constant.

However, figure 2 of Clark discloses the limitation, wherein the multiplication layer 104 is a single layer (“InAlAs”) in which the ratio of elements forming the multiplication layer 104 is constant. See par [0031].

Therefore, it would have been obvious to one of ordinary skill in art to form the device of Watanabe with the limitation of Clark in order to provide an avalanche photodiode characterized by low noise and high gain bandwidth. See par [0010] of Clark.

With regard to claim 11, Watanabe discloses all the subject matter claimed except for the limitation, wherein the multiplication layer is a layer formed from InAlAs.

However, figure 2 of Clark disclose the limitation, wherein the multiplication layer is a layer formed from InAlAs.

Therefore, it would have been obvious to one of ordinary skill in art to form the device of Watanabe with the limitation of Clark in order to provide an avalanche photodiode characterized by low noise and high gain bandwidth. See par [0010] of Clark.

With regard to claim 12, figure 6 of Watanabe discloses, wherein the multiplication layer 15 has a thickness of not more than 0.3 μm (“0.23 μm ”). See col 8 line 38.

With regard to claim 13, figure 6 of Watanabe disclose, wherein the etching stopper layer 115 is a layer formed from InP (“InP”) or $\text{In}_x\text{Ga}_{(1-x)}\text{As}_y\text{P}_{(1-y)}$ ($0 \leq x \leq 1.0$, $0 \leq y \leq 1.0$). See col 5 line 26.

Art Unit: 2893

4. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Benjamin T. Liu whose telephone number is (571) 272-6009. The examiner can normally be reached on Mon-Fri 9:30 AM-6:00PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Davienne Monbleau can be reached on 571 272 1945. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

BTL
7/28/2008

/Ngan Ngo/
Primary Examiner, Art Unit 2893